

CONFINEMENT OF TRANSGENES – SEED AND VOLUNTEER CROPS

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Safflower (*Carthamus tinctorius*), currently grown on *ca.* 80,000 hectares in the USA and <1,000 hectares in Canada, is being evaluated as a platform for plant-made pharmaceuticals (PMP). We are using safflower as a model system to determine the effects of crop biology and agronomy on the confinement of PMP transgenes in minor crops. Seed is a significant pathway for spatial and temporal gene flow. At harvest, seed may be spilled or commingled (admixture) with other crops through the multi-step grain handling process. Admixture has not been quantified for safflower. Seed dispersal from crops may lead to the formation of volunteer populations in disturbed and/or natural areas. The presence of wild safflower populations has been reported in the USA (California, Illinois, Kansas, New Mexico, Ohio and Utah), but not in Canada. The extent and longevity of these populations has not been established. Cultivated safflower, unlike its wild relatives, has reduced shattering, resulting in minimal seed lost prior to harvest. Seed dispersal from harvest operations was estimated at 5%. Safflower seed typically lacks a pappus and is thus not dispersed widely via wind or adherence to animals. However, in experiments where safflower seed was spread on the soil surface, predation by mammals and/or birds played a significant role in seed removal and short distance seed dispersal was abetted by these small animals.

Like most crops, safflower does not have prolonged seed bank persistence. Seed longevity is influenced by time of seed dispersal, depth of burial, soil moisture and soil temperature. Safflower seed has very little innate dormancy and thus is readily removed from the seed bank by germination. Initial data suggests that 20-30% of seed (protected from predation) on the surface can remain viable for one year. When seed is buried viability declines to less than 1% in the same time period, primarily due to removal by germination.

Volunteer plants can lead to admixture in the following crops. Initial field surveys indicate that safflower volunteers are uncommon in the Canadian agro-ecosystem. The survival and fecundity of volunteers is influenced by weed management practices in subsequent crops. In experiments where volunteers were planted, safflower seed production depended on the competitive ability of the crop, the type of herbicide used and location. Because safflower requires a longer time for maturity than most crops, heads contained few viable seed extractable at harvest. However, if volunteer safflower seed is produced, it may not be separated from several common cereal crops grown in Canada. Best management practices to reduce gene flow from PMP safflower should include post-harvest tillage to prevent seed dispersal by small vertebrates and to reduce seed longevity. Furthermore, the choice of subsequent cropping practices (crop choice, seeding rate, planting date) and herbicide applications (choice, timing and redundancy) should be optimized to control PMP safflower volunteers and reduce admixture.